Cook Inlet Basin

NAWQA News

National Water-Quality Assessment Program

Status Report, Winter–Spring 2002

What is NAWQA?

The Cook Inlet Basin in south-central Alaska (fig. 1) is one of about 60 National Water-Quality Assessment (NAWQA) study units designed to assess the status and trends of the Nation's water quality. This program integrates the monitoring of surface- and ground-water chemistry with the study of aquatic ecosystems. The Cook Inlet Basin study began in 1997.

Why is water temperature important in the Cook Inlet Basin?

Water temperature is an important physical factor for the five species of Pacific salmon that use many of the streams and rivers in the Cook Inlet Basin for spawning and rearing. To maximize survival, each species of Pacific salmon has adapted to specific spawning times and temperatures in order that incubation and emergence occur at the most favorable time of the year. The physiologically optimum water temperature for salmon depends on the species, the life stage, and the season. Temperature increases may affect the process of transition from freshwater to saltwater (smolting) in juvenile salmonids as well. Adult cold-water fish species may cease to migrate or die unspawned if exposed to long periods of warmer-than-usual temperatures.

A detailed discussion of stream water temperature in the Cook Inlet Basin may be found in "Water temperature of streams in the Cook Inlet Basin, Alaska, and implications of climate change," U.S. Geological Survey Water-Resources Investigations Report 01–4109.

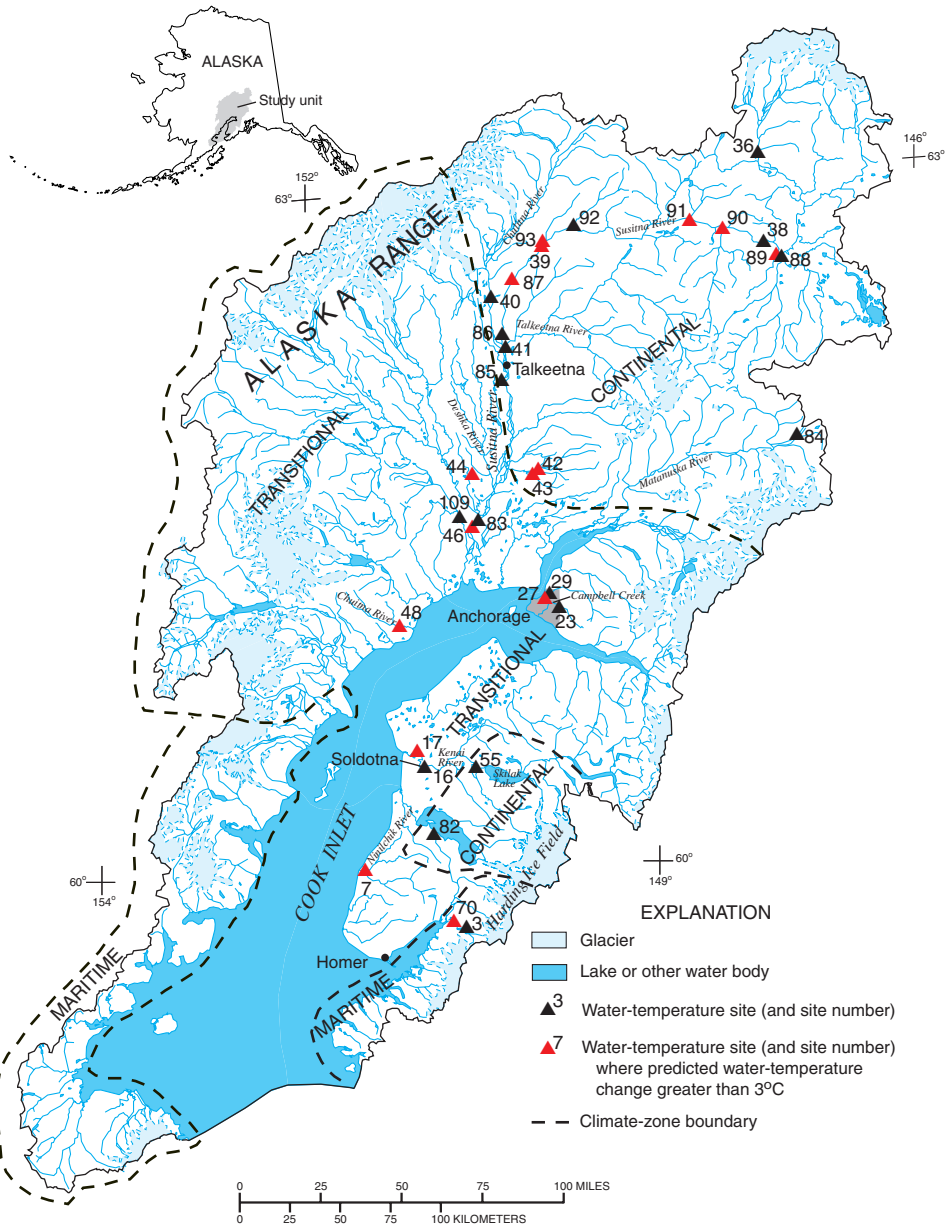

Figure 1. Water-temperature sites and climate zones in the Cook Inlet Basin.

USGS science for a changing world

Cook Inlet Basin, Alaska
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ak.water.usgs.gov/Projects/Nawqa

U.S. Department of the Interior
U.S. Geological Survey

Alaska has experienced the largest regional warming of any State in the United States—a rise in annual average temperature of about 3°C and a rise in average winter temperature of about 4.5°C since the 1960s. Extensive melting of glaciers and thawing of permafrost have occurred during this period. Warming has also been associated with an increase in precipitation of about 30 percent between 1968 and 1990. Continued global warming may alter spawning and rearing habitat for Pacific salmon in the Cook Inlet Basin.

What are the current water-temperature conditions for streams in the Cook Inlet Basin?

- Water temperature from sites on the Kenai Peninsula is dependent on basin characteristics. Streams and rivers such as Beaver Creek and the Ninilchik River that drain lowland areas have higher water temperatures than watersheds that contain glaciers such as the Bradley River.
- In the Municipality of Anchorage, South Fork Campbell Creek, which drains a relatively high elevation watershed, has the coldest water temperature. Chester Creek, an urbanized basin, has warmer temperatures, and Ship Creek, downstream from a powerplant, has the warmest temperatures in the winter.
- The Susitna River is the largest river in the Cook Inlet Basin. In the headwaters, glaciers dominate the basin, and, as a result, water temperatures during the open-water season do not exceed 8.5°C. The Susitna River gradually warms downstream until it reaches the Chulitna and Talkeetna Rivers. The inflow from these two rivers lowers the water temperature. From this point, water temperature gradually increases downstream.

How could we model the effects of potential climate change on water temperature?

We compiled water-temperature data from 32 sites in the Cook Inlet Basin (fig. 1). A model that uses air temperature as input to predict water temperature as output was tested and produced acceptable results for 27 sites (table 1). In glacier-dominated basins, the model was not as accurate. The model then was used to simulate future trends in water temperature based on increased air temperatures due to climate warming. According to the Canadian Climate Model and the United Kingdom Hadley Center Model, mean annual air temperature will increase 7.2°C in the northern half of the Cook Inlet Basin and 8.5°C in the western Cook Inlet and on the Kenai Peninsula. Both models assume a doubling of carbon dioxide. Results indicate that 15 sites have a predicted water-temperature change of 3°C or more, which is considered significant for the incidence of disease in fish populations.

Although fatal temperatures for salmon in the Cook Inlet Basin are unlikely to result from a doubling of carbon dioxide, the incidence of infection within salmon fisheries may rise.

Table 1. Predicted water temperatures due to climate change, Cook Inlet Basin, Alaska

[See fig. 1 for site locations]

Site number	U.S. Geological Survey station name	Water temperature (degrees Celsius)					
		Minimum		Maximum		Mean	
		Weekly	Change	Weekly	Change	Weekly	Change
7	Ninilchik River at Ninilchik	0.0	0	14.5	0.2	13.4	5.3
16	Kenai River at Soldotna	.0	.0	13.9	1.3	11.5	2.4
17	Beaver Creek near Kenai	.0	.0	13.6	1.0	12.9	5.3
23	South Fork Campbell Creek near Anchorage	1.2	1.2	9.4	-1.3	7.7	1.2
27	Chester Creek at Arctic Boulevard at Anchorage	.0	.0	15.6	.6	13.6	3.9
29	Ship Creek below Power Plant at Elmendorf Air Force Base at Anchoragte	4.0	3.8	12.2	-3.7	1.8	1.8
38	Susitna River near Cantwell	.0	.0	12.4	.6	11.0	2.9
39	Susitna River at Gold Creek	1.7	1.6	13.5	.9	11.6	3.5
41	Talkeetna River near Talkeetna	3.2	3.0	11.6	.4	1.2	2.6
42	Willow Creek near Willow	.3	.2	13.6	.9	11.4	4.3
43	Deception Creek near Willow	.0	.0	15.4	1.3	12.2	4.4
44	Deshka River near Willow	.1	.1	24.6	4.0	16.2	5.4
46	Susitna River at Susitna Station	3.9	3.7	15.2	1.0	13.8	3.5
48	Chuitna River near Tyonek	.1	.1	18.3	1.7	15.7	7.1
55	Kenai River below Skilak Lake outlet near Sterling	1.0	1.0	12.4	.0	11.8	2.4
70	Bradley River near tidewater near Homer	.2	.2	12.9	1.0	1.2	3.7
83	Susitna River above Yentna River near Susitna Station	3.5	3.5	12.6	.8	11.3	2.7
85	Susitna River at Sunshine	.5	.3	12.3	.2	1.4	2.7
86	Susitna River near Talkeetna	.5	.3	13.6	.3	11.9	2.6
87	Susitna River near Curry	6.9	5.8	15.4	1.3	13.7	4.2
88	Oshetna River near Eureka	4.4	3.6	12.8	.6	1.9	2.8
89	Goose Creek near Eureka	3.7	3.3	13.0	.8	11.3	3.9
91	Watana Creek near Gold Creek	3.1	2.5	12.3	.8	1.8	3.3
92	Portage Creek near Gold Creek	3.8	2.8	1.3	-.2	8.1	1.6
90	Kosina Creek near Eureka	3.7	3.6	13.5	.8	12.0	3.6
93	Indian River near Gold Creek	2.2	.6	13.4	1.5	11.2	3.8
109	Yentna River near Susitna Station	7.7	6.4	12.3	.5	11.5	3.0

What was the range of water temperatures at the NAWQA sites from October 1998 to October 2001?

The six fixed sites that we monitored for water temperature can be discussed as three pairs of sites. In the Anchorage area (figs. 1 and 5), the South Fork Campbell Creek and Chester Creek at Arctic Boulevard sites offer comparison of an essentially undeveloped basin and a highly urbanized basin, respectively (fig. 2). The effect of urbanization is shown by higher summer maximum temperatures; generally about 13°C versus about 10°C for the undeveloped basin.

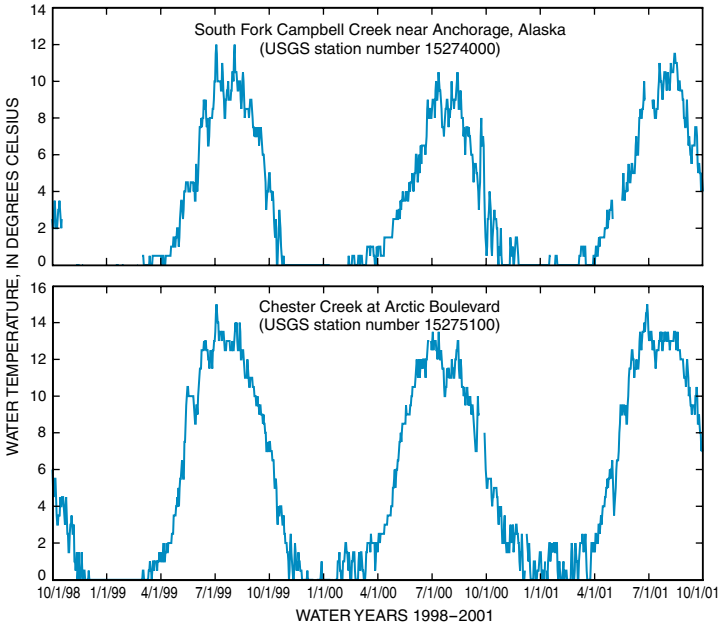

Figure 2. Water temperatures in an essentially undeveloped basin (South Fork Campbell Creek) compared to a highly urbanized basin (Chester Creek at Arctic Boulevard).

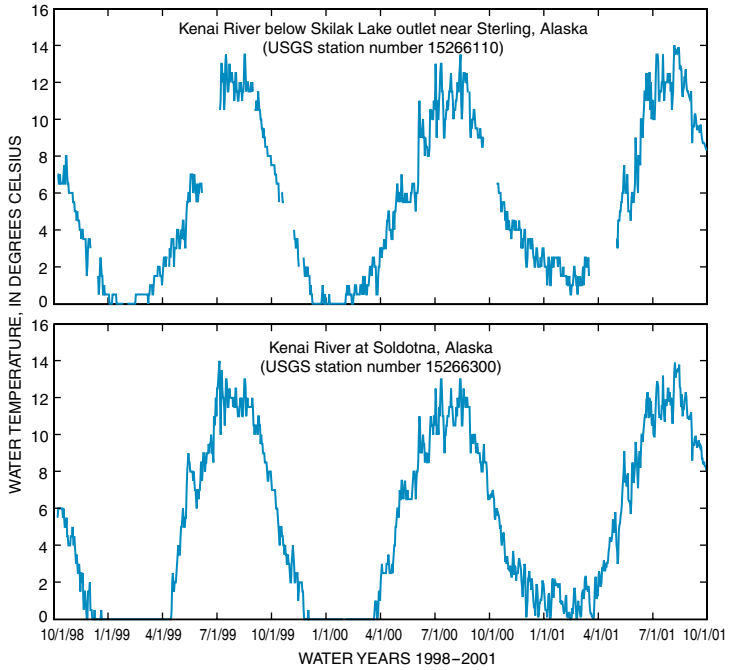

Figure 3. Water temperatures at two sites on the Kenai River.

Two sites were monitored on the Kenai River (fig. 3). The Kenai River Basin contains large areas of glaciers in its headwaters and has two large mainstem lakes upstream from the monitoring sites. The record for the site below the Skilak Lake outlet shows the moderating influence of the lake as shorter periods of 0°C water temperature when compared to the site at Soldotna.

Two sites were monitored in lowland, forested settings—the Ninilchik River and the Deshka River. The Ninilchik River summer temperatures are moderated by its proximity to the Cook Inlet, whereas the Deshka River has the highest summer temperatures of the six fixed sites.

Water temperature was measured at sites in Anchorage (fig. 5 and table 2) at 15-minute intervals for the purpose of comparing streams that have different degrees of development in their watersheds. A natural gradient from cooler temperatures at sites farther upstream and at higher elevations to warmer temperatures at downstream sites is expected. The sites in watersheds having the greatest degree of development (27, 64, 65, and 67) consistently had the highest water temperatures. Instantaneous maximum temperatures occasionally exceeded the State of Alaska's upper limit (13°C) for spawning and egg and fry incubation: at site 64 on 1 day, at site 65 on 2 days, at site 67 on 3 days, and at site 27 on more than 30 days from May 1 to September 30, 2000.

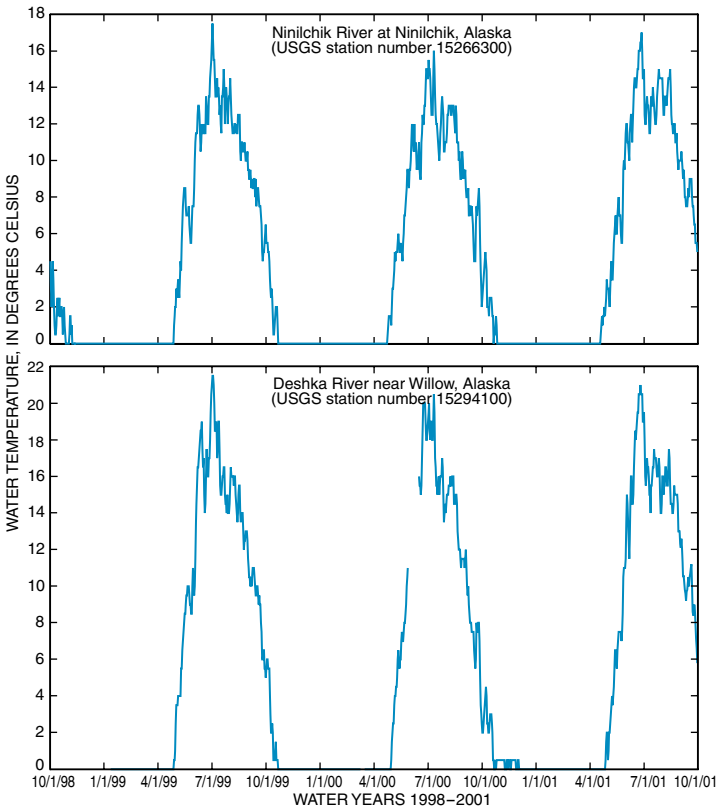

Figure 4. Water temperatures at two sites in forested-lowland settings on the Ninilchik and Deshka Rivers.

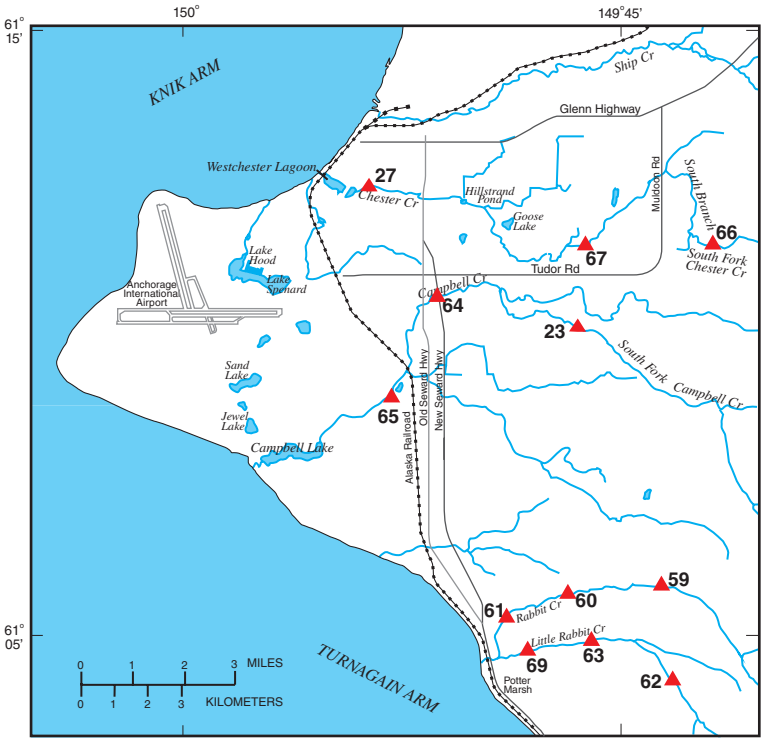

Figure 5. Water-temperature sites in the Anchorage area.

NEW PUBLICATION FROM THE COOK NAWQA

Ourso, R.T., 2002, *Effect of urbanization on benthic macroinvertebrate communities in streams, Anchorage, Alaska*: U.S. Geological Survey Water-Resources Investigations Report 01–4278, 34 p. [*released as* URL: <http://pubs.water.usgs.gov/wri014278>]

EXPLANATION

▲ Anchorage water-temperature sites:

23 South Fork Campbell Creek near Anchorage
27 Chester Creek at Arctic Boulevard at Anchorage
59 Rabbit Creek at Hillside Drive near Anchorage
60 Rabbit Creek at East 140th Avenue near Anchorage
61 Rabbit Creek at Porcupine Trail near Anchorage
62 Little Rabbit Creek at Nickleen Street near Anchorage
63 Little Rabbit Creek at Goldenview Drive near Anchorage
64 Campbell Creek at New Seward Highway near Anchorage
65 Campbell Creek at C Street near Anchorage
66 South Branch of South Fork Chester Creek at Tank Trail near Anchorage
67 South Branch of South Fork Chester Creek at Boniface Parkway near Anchorage
69 Little Rabbit Creek near Anchorage

Table 2. Summer 2000 water temperature at sites in Anchorage

[Site: For site names and locations, see fig. 5. —, no data]

Site	May			June			July			August			September		
	Maximum	Mean	Minimum	Maximum	Mean	Minimum	Maximum	Mean	Minimum	Maximum	Mean	Minimum	Maximum	Mean	Minimum
23	8.0	3.6	0.5	11.5	6.5	2.5	13.0	8.7	6.5	12.0	8.4	4.0	9.0	5.3	0.0
27	13.0	8.4	4.0	15.5	11.8	9.0	15.5	11.9	9.0	16.0	11.1	7.5	13.0	8.4	4.5
59	7.1	3.5	1.6	7.8	4.3	1.9	9.2	6.4	4.3	9.5	6.7	3.5	7.5	4.5	.8
60	8.8	4.0	.9	8.8	5.0	2.6	—	—	—	—	—	—	—	—	—
61	8.7	4.3	1.0	9.3	5.6	2.9	10.4	7.6	5.6	11.0	7.8	4.2	8.8	5.4	.9
62	7.2	2.5	.3	8.6	4.8	2.0	9.8	6.5	4.4	10.6	7.1	3.4	7.9	4.7	.4
63	8.6	3.5	.3	10.3	6.2	2.7	10.6	7.8	5.8	11.1	7.8	4.0	8.5	5.3	.5
64	10.6	6.1	2.2	12.3	7.8	4.2	13.2	9.5	7.4	12.5	9.2	5.2	9.2	6.0	.4
65	11.3	6.8	2.6	12.7	8.5	5.1	13.8	10.1	7.8	13.2	9.8	5.9	10.2	6.5	.9
66	8.0	4.1	.3	9.7	6.2	2.9	9.4	6.8	5.2	9.3	6.8	3.8	—	—	—
67	11.0	7.0	3.1	12.7	9.0	5.9	13.7	9.8	7.2	15.4	9.1	5.6	10.3	6.4	1.6
69	9.0	4.0	.6	10.4	6.9	3.4	11.5	8.6	6.8	12.1	8.6	4.7	9.3	5.9	.7

This newsletter was prepared by the Cook Inlet Basin study team. The purpose of the newsletter is to keep members of the Cook Inlet NAWQA liaison committee informed of our activities. The newsletter represents the views of the COOK NAWQA team and is intended for information purposes only. It is not intended for redistribution or publication and should not be cited. If you would like your name removed from or a name added to the mailing list for this newsletter, or if you have any comments regarding this newsletter or our workplans, please contact project chief Steve Frenzel at (907)786-7107, or write to COOK NAWQA, U.S. Geological Survey, 4230 University Drive, Suite 201, Anchorage, AK 99508-4664, or send email to sfrenzel@usgs.gov

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